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K-86-03-0015

Critical Evaluation of Subsoiling Tillage

by Mike Grevers

(submitted to: Agriculture Development Fund)

R-88-03-0015

Critical Evaluation of Subsoiling Tillage

by Mike Grevers

(submitted to: Agriculture Development Fund)

This report summarizes the work on subsoiling tillage from 1986 to 1988. The work was supported by a grant from the Agriculture Development Fund. Details of the work are given in the previous progress reports dated February 26, 1987; July 13, 1987 and December 22, 1987. Published reports include presentations at the 1987 and 1988 Soils and Crops Workshop meetings (attached).

The work was initiated by Ed Tanner in the fall of 1985 with three deep ripped fields in the Tisdale area. Since then nine more deep ripped and/or paraplowed field tests were added to the project.

The objective of the study was to evaluate the short and long-term effect of deep tillage on soil physical properties and crop production. Of the 12 field tests, six represent solonetzic soils (hardpan soils) and 6 represent chernozemic soils. The field tests generally involve replicated strips of 40-60 feet in width by $^1/_2$ mile in length. The sites are located at Tisdale (4), Arborfield (2), Cut Knife (1), Lucky Lake (1), Glenside (1), Birsay (1), Moose Jaw (1) and Chamberlain (1).

Soil structure was improved with paraplowing and with deep ripping. This effect resulted in greater soil water recharge during the fall to spring period. Soil strength in the surface soil layer was also reduced, particularly due to deep ripping.

Crop establishment was a problem on the solonetzic soils in the first year following deep ripping. In 1986 the crop was able to recover the "set-back" due to poor seedbed conditions in the ripped area. In 1987, however, relatively dry conditions prevented crops on previously ripped areas to fully recover.

Crop yield was improved significantly on three soloentzic soils over a two year period. Crop yield was reduced slightly on two solonetzic soils where seedbed problems existed in spring. For the chernozemic soils crop yield was basically not affected by either deep tillage operation except at one side where deep ripping increased yields. The summer of 1987 was characterized by frequent "timely" rains in some areas of the province. This effect may have reduced the impact of deep ripping on crop growth for three of the chernozemic soil sites.

Continued monitoring of these sites will take place for another two years. Two sites were added in the fall of 1987 when two Carrot River soils were deep ripped. Economic analysis will be carried out at the end of the study. However, after two years following deep ripping, the economic benefits of deep ripping at one site (Boxall, Tisdale) has exceeded the initial cost of deep ripping.

Expenditures

The University of Saskatchewan accountants report will be sent to you. However I have included copies with this report.

Salaries and fringe benefits		$11,662.00
Materials and supplies		11,067.00
Travel expenses		11.149.00
Equipment		381.00
Equipment maintenance		116.00
Computing charges		2,955.00
Printing charges		39.00
Total		$37,369.00

Charges not yet processed:		
Soil compaction testing probe	$ 300.00	
Protein analysis	120.00	
Long distance phone calls	200.00	
Stationary supplies	107.00	
Computing charges	368.00	
Soil testing 100 samples @ $15 ea.	1,500.00	
Subtotal		2,595.00
TOTAL		$39,964.00

Installments to date	$35,000.00	
Remainder	5,000.00	
Total		$40,000.00

(NOTE: There is a small balance of $36.00 which should be left to cover incidental costs.)

ADF R-86-10-0015

Progress Report on Deep Ripping Research Grant

by Mike Grevers

(Submitted to: Agric. Extension District Board #26)

A deep ripping research project was initiated by Ed Tanner (Agric. Rep. at Tisdale), during the fall of 1985. This work included 3 field plots on different farm fields in the Tisdale area. On August 21, 1986, M. Grevers (Soil Sci.Dept., U of S) was awarded an A.D.F. sub-contract allowing him to evaluate deep ripping in the northern grain belt. One of the main conditions of the contract was for M.Grevers to include in his work the 3 plots established by Ed Tanner and a proposed deep ripping plot at Cutknife.

The work to date involves two parts: 1) monitoring of soil and crop conditions in the 3 established plots and 2) establishment of additional deep tillage plots. Crop yields in the 3 established plots at Tisdale, were substantially increased due to deep ripping. At the first site (Boxall) wheat yield was increased by 26 % (8.7 bu/ac), at the second site (Morgan) barley yield was increased by 16% (7.7 bu/ac) and at the third site (McEwen) the yield of peas was increased by 45% (604 lbs/ac). Soil physical conditions of these fields in the fall of 1986, indicated trends showing less dense and more aerated soil conditions in the deep ripped parts of the fields. This information was presented at the 1987 Soils & Crops Workshop, held at Saskatoon on February 20,1987. The paper thus presented is included in this report.

During the fall of 1986, further field plots were established in order to evaluate deep ripping and paraplowing on a variety of field and climatic conditions. Paraplowing was done on two of the earlier established plots at Tisdale. Strips 800 m by 12 m were paraplowed

alongside the previously deep ripped strips. Paraplowing represents a more economical alternative to deep ripping, although it may be less effective on a long-term basis. Also at Tisdale, a farm field trial was established on a soil where deep ripping was considered to be not required and therefore acts as a control. Two sites were located at Arborfield and deep ripping was carried out. Due to the severity of the Solonetzic condition of the Arborfield sites, paraplowing was not attempted. At Cutknife, both deep ripping and paraplowing were carried out. The farmer at Cut Knife, Richard Foisy had applied for an A.D.F. grant for deep ripping.

Further sites were established at Lucky Lake (Al Jessiman farm), where deep ripping and paraplowing were done on chemical fallow, at Birsay (Michael Millar's farm), where paraplowing was done on an irrigated field and at Glenside (John Harrington's farm), where paraplowing was done on stubble. At present, there are 10 locations where deep ripping and/or paraplowing will be evaluated. No further sites are planned since this large number of field sites already stretches the budget of the grant.

To date $22,811 has been spent out of the total allotment of $40,000. This sum appears large however, initial costs of the project were substantial. The majority of the large initial expenditures have resulted from the deep tillage operations carried out in the fall of 1986, e.g. rental of tractors, paraplow, deep rippers and transportation of these between the field plots.

Attached is a copy of a "Statement of Receipts & Expenditures" for the period of August 21,1986 to January 31,1987. This document was prepared by C.M. Boyer, research accountant with the University of Saskatchewan.

Detailed expensese are as follows:

Salaries and fringe benefits for technician's:
Murray Nielsen (3.25 months) and
Ian McIver (2 months) ..... $ 8312.00

Materials and supplies:

Backhoe work for soil trenches	827.00	
Plywood for covering trenches	294.00	
Repairs on paraplow	212.00	
Rental of videorecorder	250.00	
Neutron tubes & couplers	2550.00	
Detailed soil salinity tests	540.00	
Miscellaneous	1079.00	$ 5752.00

Travel:

Transport of paraplow & tractor	1298.75	
Rental of vehicles for field work	4187.00	
Field expenses by staff (meals etc.)	1880.25	$ 7366.00

Equipment costs includes the purchase of a camera (Pentax K1000) with a regular and a wide angle lens, as well as the purchase and development of slides..... $ 381.00

Computing charges involves the costs from the printing of harvest tags for soil and plant samples, data entry and assimilation..... $ 1000.00

Budget for 1987

Personnel
Darwyn Pidwerbesky 4 months @ $1600 ..... $ 6400.00

Field expenses .....$ 2600.00
Vehicle rental $ 1000.00
Meals & accommodation $ 1600.00

Soil testing .....$ 1000.00
Detailed soil salinity for 5 farm fields

Harvesting costs .....$ 1400.00
Collecting and processing soil & crop samples

Computing costs:
printing tags, data entry & assimilation.....$ 1000.00

Total.....$12400.00

Summary of the budget for the duration of the project

Total support from A.D.F.....$ 40,000
Spent to date .....$ 22,811
Budget for 1987 .....$ 12,400
Budget for 1988 .....$ 4,789*

* The project was intended to be completed by March,1988. However, an extension was requested and granted to December,1988. This will allow monitoring of field conditions in the summer of 1988.

DEEP RIPPING EXPERIMENTS IN N-E SASKATCHEWAN

MIKE GREVERS
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ED TANNER
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Tisdale

(This work is supported by the Agriculture Development Fund)

INTRODUCTION

Crop growth on solonetzic soils is limited mainly by the condition of the B horizon. "The solonetzic B horizon is very hard when dry and swells to a sticky mass of very low permeability when wet" (Canada Soil Survey Committee, 1978). This horizon presents a physical limitation to the penetration of roots, water and air. Consequently, the shallower the depth to the B horizon, the shallower the zone for root proliferation and soil water storage. Chemically the solonetzic B horizons are separated from other B horizons by the fact that they must have a ratio of exchangeable Ca to Na of 10 or less (Canada Soil Survey Committee, 1978). Water soluble cations can also be used to differentiate solonetzic B horizons from chernozemic B horizons. Ballantyne and Clayton (1962) formulated the differentiating criteria after comparing chemical characteristics with morphological characteristics of 291 soil profiles, varying in degree of solonetzic development. Solonetzic soils would have greater than 50% water soluble Na in a soil layer above the C horizon, intergrades between 33 and 50%, and Chernozemic soils less than 33%. In terms of water soluble Ca/Na ratio the values they listed are: 0-0.5, 0.5-1.0, and >1.0, of solonetzic, intergrades, and chernozemic soils, respectively. There has also been a report of solonetzic soils where soluble Na contents are quite low (Ellis and Caldwell, 1955). These "magnesium solonetz" soils apparently have a narrow Ca/Mg ratio on the exchange sites.

The quality of the A horizon depends on the stage in the development of the solonetzic soil. In some of the worst cases the A horizons have little organic matter, crust easily and have an acid pH. Frequently, the C horizon contains considerable amounts of salts which limit water availability to plants. However, the type of salts present in the C horizon are usually Ca-salts, which are important with respect to the reclamation of these soils. The extent of solonetzic soils in Saskatchewan has been estimated at 1.5 million hectares (Ballantyne, 1982).

Deep tillage operations attempt to disrupt the B horizon and improve root and water penetration and subsequent leaching of salts. Deep plowing mixes the Na-rich Bnt horizon with the Ca-rich C horizon. The Na is then replaced by the Ca on the exchange sites in the soil, the highly soluble Na can then be leached with rainwater. In some cases, lime from the C horizon when mixed with the A horizon, can neutralize the acidity in the A horizon. Much of the deep plowing research in Western Canada has been done in Alberta (Cairns, 1961, 1962; Bowser and Cairns, 1967) . In Saskatchewan Ballantyne (1982) studied soil conditions and crop yields for 5 years following deep plowing of solonetzic soils near Radville. Deep plowing had increased topsoil levels of clay, fine clay, pH, $CaCO_3$ and water soluble Ca. Water soluble Na was decreased. These changes persisted over a 5 year period. Average wheat yields following deep plowing were higher for all 5 years (Fig 1).

Deep ripping has been found to be less effective than deep plowing in reducing the exchangeable sodium percentage of solonetzic soils (Alubaidi and Webster, 1982). Deep ripping does affect soil physical parameters. Bole (1986) found increased surface infiltration and hydraulic conductivity 3.5 years following deep ripping in plots in Vauxhall, Alberta. Soluble Na and sodium adsorption ratio were lower in deep ripped plots. However, this effect only lasted for 2 years. Alubaidi and Webster (1982) found that deep ripping had resulted in increased leaching of salts. Information on crop yields following deep ripping is limited. Lavado and Cairns (1980) found that in one field wheat yields were increased, while in another field the yields were decreased. Apparently in the

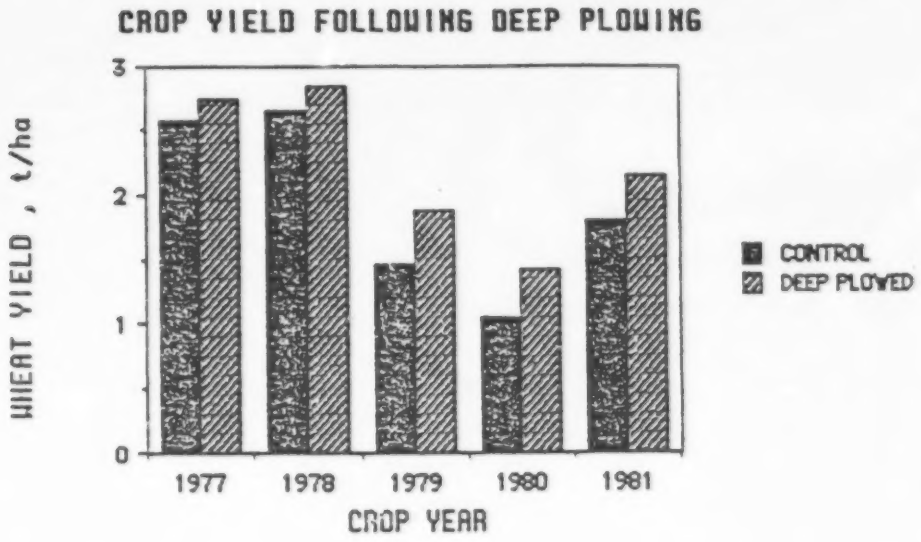

Fig. 1. Crop yields following deep plowing in 1976 (Ballantyne, 1982).

second field, ripping had resulted in deteriorated topsoil conditions in terms of reduced extractable Ca and increased extractable Na.

In the Tisdale region, farmers had noted yield increases on strips of land which had been ripped during the installation of power lines. Staff from the Saskatchewan Soil Survey Unit identified solonetzic profiles in a number of fields in this area. The objective of this study is to determine the feasibility of deep ripping in the northern grain belt.

MATERIALS AND METHODS

The sites are located north and east of Tisdale. The fields were surveyed by staff from Saskatchewan Soil Survey Unit and some of the soil profiles excavated showed morphological features common to solonetzic soils. Chemical characteristics of the fields are listed in Table 1. Water extractable cations were measured. Exchangeable cations and C.E.C. were estimated from water soluble cations and % saturation using the Gapon coefficient as described by van Beek et al. (1975). The fields were deep ripped in October

Table 1. Chemical characteristics of deep ripped fields.

Location (farm)	Depth (cm)	C.E.C.* me/100g	pH	E.C. mS/cm	S.A.R.	% Na H_2O sol.	Ca/Na H_2O sol.	Ca/Na* exchange
McEwen	0-15	32.6	5.7	0.4	0.8	24.8	1.69	14.5
	15-30	35.8	6.7	0.3	1.2	35.3	0.82	10.1
	30-60	42.6	8.0	0.6	2.2	44.4	0.54	7.9
	60-90	57.0	8.1	1.0	3.9	55.8	0.29	6.7
	90-120	65.2	7.9	3.6	3.2	26.6	1.15	11.9
Boxall	0-15	35.8	6.2	0.7	1.1	24.5	1.46	10.7
	15-30	24.4	7.2	0.4	1.6	39.9	0.64	4.2
	30-60	61.9	7.9	1.5	2.4	34.2	0.76	13.1
	60-90	73.3	7.9	5.9	4.9	30.2	0.92	11.2
	90-120	78.2	7.5	7.5	7.0	37.3	0.58	9.5
Morgan	0-15	35.8	5.9	0.9	2.9	48.6	0.51	4.3
	15-30	48.9	7.4	0.8	4.5	66.3	0.26	4.7
	30-60	65.2	8.1	1.8	7.7	70.5	0.17	4.8
	60-90	92.9	8.1	4.5	10.3	62.2	0.21	23.5
	90-120	104.3	8.0	6.6	9.9	51.7	0.36	

* Indicates estimated values

1985. A KELLO-BILT subsoiler was pulled with a 1150 VERSATILE tractor (450 h.p.), shanks were 61 cm apart and the depth setting was 75 cm. At each location ripping was carried out in strips 12 meters wide and 800 meters long. Soil conditions at the time of ripping were "dry". Following ripping, the fields were disced a number of times in order to smooth down the extreme surface roughness left by the ripping. During 1986, crop yields were monitored both with a square meter and with a weigh wagon. Soils were sampled in the fall of 1986 for moisture, bulk density and for detailed salinity analysis.

RESULTS AND DISCUSSION

According to the differentiating criteria set out by Ballantyne and Clayton (1962), the McEwen and Morgan sites represent solonetzic soils. At McEwen the B horizon contains 56% water-soluble Na at 60-90 cm depth and at Morgan both the A and the B horizons contain water-soluble Na equal to or exceeding 50%. These B horizons also satisfy the criteria for exchangeable Ca/Na ratios to be equal to or smaller than 10. The Boxall site appears to be less severely solonetzic and falls in the intergrade category, between chernozemic and solonetzic. Seasonal fluctuations in water soluble Na content must be taken into account when assessing water-extractable cations for soil analysis. Field seeding operations were done without making any special adjustments when the seeder traversed deep ripped strips. Consequently in the ripped strips seeding depth was often deeper than intended. This phenomena appeared to have resulted in delay of plant establishment at the Morgan site. This "set-back" in crop growth had disappeared by mid summer.

Yields at all three sites were higher in the ripped strips (Table 2). Morgan's barley yields were greater by 16% (7.7 bu/ac). Weigh wagon results indicated more conservative increases between 3.7 and 6.0 bu/a. Boxall's wheat yields were greater by 26% (8.7 bu/ac) and McEwen's peas yielded 45% more on tilled strips (604 lbs/ac). It must be pointed out that the north-east was quite "dry" for most of the 1986 growing season.

Table 2. Crop yields for 1986 deep ripping experiment.

Location	Tillage	Dry Matter kg/ha	Grain kg/ha	C.V.* %	Grade	Soil** Strength kg/cm^2	Soil Moisture %
			Barley				
Morgan	Control	5362 a	2558 a	21.6	1	75.8	17.4
	Ripped	6264 b	2972 b	19.6	1	47.2	21.3
			Wheat				
Boxall	Control	4262 a	2284 a	22.2	1	16.8	16.3
	Ripped	5795 b	2872 b	19.3	1	11.8	20.2
			Peas				
McEwen	Control	2899 a	1516 a	23.0	2	83.8	12.8
	Ripped	4217 b	2193 b	24.5	2	66.8	15.1

*Coefficient of variation

**Penetrometer reading at 7.5 cm

Values followed in columns by the same letter are not significantly different at the 5% level.

Consequently crops growing on deep ripped soils possibly suffered from less water stress than those growing on the non-ripped soils. There was considerable variability in crop yield along the 800 m transects, especially for the control. Soil strength, measured at the time of harvest was in each case lower in the ripped area. However, soil moisture conditions of the top 15 cm were also higher in the ripped areas. It is therefore difficult to assess the importance of the differences in soil strength.

Soil physical properties were measured during the fall of 1986. Soil bulk density appeared to be lower in the deep ripped plots, but differences were not significant (Table 3). At the Boxall site trenches were dug with the help of a backhoe, in order to expose complete soil profiles. This allowed for additional analysis of soil structure in terms of aggregate size distribution and field air permeability. Aggregates in the surface soil layers tended to be of smaller diameter in the deep ripped plots but differences were not significant. Air permeability tended to be greater in the top 30 cm in deep ripped plots, but values were not significantly different. One of the problems with analysis of soil structure in these soils is the extreme spatial variability resulting in very large variances. Monitoring of soil chemical characteristics over the next two years may reveal if leaching of Na-salts is occurring in deep ripped soils.

The deep ripping tillage work has been extended to now include paraplowing to a depth of 50 cm. Additional sites were established in the fall of 1986 at Arborfield, Cut Knife, Lucky Lake, Birsay and Glenside. The sites represent a range of soil textures from medium to heavy, as well as a range in solonetzic development. Crop and soil monitoring will continue for at least 2 more years.

Neutron tubes have been installed at 7 sites. These tubes allow for the measurement of soil moisture content to a depth of 120 cm, using a neutron probe. Furthermore, soil bulk density can be measured to the same depth with a gamma probe. A further 3 sites will receive neutron probes this spring. The above allows for measurement of soil moisture conditions and density at specific locations for the next two years. By returning to exactly

Table 3. Soil physical properties of field plots in the fall, 1986

Location	Depth (cm)	Control	Deep Ripped
		Bulk Density (gm/cm3)	
Morgan	25	1.40	1.21
	40	1.36	1.29
	60	1.32	1.32
	80	1.37	1.36
	100	1.40	1.40
	120	1.43	1.43
McEwen	25	1.24	1.25
	40	1.38	1.34
	60	1.37	1.35
	80	1.41	1.40
	100	1.44	1.47
	120	1.48	1.50
Boxall	25	1.30	1.22
	40	1.31	1.27
	60	1.35	1.33
	80	1.38	1.39
	100	1.43	1.42
	120	1.43	1.42
		Aggregate Size Distribution (mm)	
Boxall	0-15	10.88	6.69
	15-30	17.39	15.88
		Field Air permeability (*10-6 cm^2)	
Boxall	0-15	6.50	3.95
	15-30	1.18	3.84
	30-45	0.65	1.72
	45-60	0.59	0.38

the same location for the measurements for moisture and density at each sampling interval, sampling variability is reduced.

CONCLUSIONS

Solonetzic soils were identified in the Tisdale area. Deep ripping of these soils resulted in substantial yield increases in wheat, barley and peas. There was considerable variability in crop yield along 800 m transects, especially in the non-ripped parts of the fields. Analysis of soil physical properties revealed no significant trends attributable to deep ripping. The soils did tend to be less dense and more aerated following deep ripping. Additional field plots were established in the fall of 1986, at Arborfield, Cut Knife, Lucky Lake, Birsay and Glenside. A paraplow was used in a number of the field sites. At present 10 field sites are included in the study, these represent a range in soil texture, as well as in solonetzic development. Long-term monitoring of soil physical and chemical parameters over at least a 3 year period is required to fully evaluate the effectiveness of deep ripping in this region.

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PROGRESS REPORT ON DEEP RIPPING RESEARCH GRANT

by MIKE GREVERS

(Submitted to: Agriculture Extension Board #26)

This is the second report on the progress on Deep Ripping Research by Mike Grevers.

Deep ripping research presently includes 12 farm cooperators located in Arborfield, Tisdale, Cut Knife, Glenside, Lucky Lake, Birsay, Moose Jaw and Chamberlain. The sites are representative of soil conditions where deep ripping is likely to be beneficial, as well as of soil conditions where deep ripping is not expected to result in improved crop production.

In the spring of 1987 field conditions at all 12 locations were monitored for soil density and soil moisture. In addition to the physical data, samples were collected for chemical criteria. Soil nitrate nitrogen was measured, as well as detailed salinity of soils which had not previously been sampled.

The general conditions of all sites are as follows:

Cooperator	Location	Soil Association and Texture	Tillage Done*	Potential for deep tillage to improve crop production
D. McEwen	Tisdale	Arborfield SiC	R,,P	good
J. & G. Boxall	Tisdale	Arborfield SiC	R, P	good
D. Morgan	Tisdale	Arborfield C	R	very good
G. Rice	Tisdale	Tisdale SiCL	R	marginal
V. Cragg	Arborfield	Arborfield C	R	very good
M. Chabot	Arborfield	Arborfield C	R	very good
R. Foisy	Cut Knife	Oxbow L	R, P	marginal
J. Harrington	Glenside	Echo SiCL	P	variable
M. Millar	Birsay	Fox Valley CL	P	unknown
A. Jessiman	Lucky Lake	Sceptre HC	R,,P	unknown
D. Swenson	Moose Jaw	Haverhill L	R	unknown
L. Ackerman	Chamberlain	Weyburn L	R	poor

* R = deep ripped; P = paraplowed

Spring Results

Soil density in the 1985 ripped strips (Boxall, McEwen and Morgan) was not significantly lower than in the control areas. For the other sites (1986 ripped and paraplowed) soil density was generally lower in the top 30-45 cm. Soil moisture levels in the spring were generally higher following deep tillage due to greater soil water recharge during the fall to spring period (see below).

Cooperator Site	Tillage	Soil water to 120 cm depth	Over-winter gain
		--cm H_2O--	--cm H_2O--
McEwen	Paraplowed	51.3	17.2
	Ripped	45.8	11.4
	Control	45.8	10.4
Boxall	Paraplowed	43.6	13.6
	Ripped	42.6	6.3
	Control	40.8	6.3
Morgan	Ripped	37.6	3.2
	Control	34.0	-0.8
Foisy	Paraplowed	23.6	2.1
	Ripped	23.7	-0.7
	Control	23.3	1.0
Harrington	Paraplowed	26.9	1.2*
	Control	25.2	3.0
Millar	Paraplowed	29.9	3.0
	Control	29.7	3.0
Jessiman	Paraplowed	40.0	6.5
	Ripped	35.1	3.2
	Control	33.6	1.4

* Substantial fall rains prior to fall sampling may have resulted in less additional recharge

Crop emergence and establishment was evaluated during the second week in June. Poor crop stands were observed where deep ripping had been carried out in 1986 in the Tisdale and Arborfield areas. Generally loose soil conditions, poor seed placement and dry soil conditions were the major factors responsible for the above. Crop establishment was normal in the 1985 ripped strips. At the other sites crop establishment was not affected by previous tillage treatments.

Work Schedule

At all 12 farm locations the crop will be sampled by harvest time. Total dry matter, grain yield and quality will be measured using square yard samples. Soil moisture and soil density will also be measured at that time.

Financial Status of the Research Grant

The balance as of April 30, 1987 is -$5,218.00 (see attached document from the U. of S. Research Accountant). A total of $20,000 has been installed by the Agricultural Development Fund. The total amount of ADF support is $40,000.00. Subsequently, I am looking forward to receiving the next installment of $10,000.00.

If any further information is required regarding the project, please contact me.

Sincerely,

Mike Grevers

MG/nw

7-74123
R-86-10-0015

UNIVERSITY OF SASKATCHEWAN
Agriculture Development Fund
"Critical Evaluation of Subsoiling Tillage (Deep Ripping)"
Under the Direction of M.C. Grevers, Soil Science
Statement of Receipts & Expenditures for the Period
February 1 - April 30, 1987

Receipts

Overexpenditure as of January 31, 1987	$12,811	
Government of Saskatchewan - April 1987	10,000	
Total Funds Available		($2,811)

Expenditures

Salaries	$ 955	
Fringe Benefits	50	
Materials & Supplies	1,586	
Travel	(300)	
Equipment Maintenance	116	2,407
Overexpenditure as of April 30, 1987		($5,218)

PROJECT DIRECTOR

(Ms.) C.M. BOYER
RESEARCH ACCOUNTANT

PROGRESS REPORT ON DEEP RIPPING RESEARCH GRANT

by MIKE GREVERS

(Submitted to: Agriculture Extension Board #26)

This is a third and final report on deep ripping research. A total of 12 farm fields were monitored for soil physical properties, water relations and crop yields.

The effect of deep ripping on crop yields for all the sites is shown in Table 1. Deep ripping increased wheat yields by 89% (Boxall), canola yields by 10% (Rice), flax yields by 14% (Morgan) and flax yields by 18% (McEwen).

Table 1. Crop yields of 12 farm fields.

Location	Crop	Yields in bu/acre			% yield increase by tillage	
		Check	Ripped	Paraplowed	Ripped	Paraplowed
Boxall	Wheat	18.4	34.8	29.5	89	60
McEwen (1)	Flax	21.0	24.0		14	
McEwen (2)	Flax	22.5		23.1		3
Morgan	Flax	23.0	27.1		18	
Rice	Canola*	?	?		10	
Chabot	Peas	31.2	28.6		-8	
Cragg	Wheat	41.8	34.9		-17	
Foisy	Lentils	40.4	41.1	42.3	2	5
Harrington	Wheat	20.0		19.8		-1
Millar	Flax	34.7		35.0	1	
Jessiman	Wheat	44.1	44.3	46.4	1	5
Ackerman	Wheat	18.8	22.4		19	
Swenson	Wheat	40.3	47.0		17	

*Field was swathed before yield samples could be taken. Yield increase was estimated by the farmer.

There were yield decreases due to deep ripping on each of the Arborfield sites. Poor seedbed preparation in the ripped strips was followed by very dry conditions early in the growing season. Consequently, crop emergence was poor in the ripped strips, which eventually resulted in yield decreases of 17% at Cragg's and of 8% at Chabot. Crop growth was sporadic, but the crop that had emerged was often thicker and taller than that in the check part of the field.

In the other farm fields there were no statistically significant differences in crop yield due to deep ripping. However, in each case the deep ripping had resulted in yields that were at least as high as the yields in the check areas.

Paraplowing only resulted in a significant yield increase at Boxall's (60%). At the other farm sites paraplow yields were similar or slightly greater than the check yields.

Yield increases in terms of total dry matter production indicate similar patterns as with those of grain yield (Table 2). However, the yields due to ripping for the Arborfield

Table 2. Total dry matter yields of 12 farm fields.

Location	Crop	Yields in bu/acre			% yield increase by tillage	
		Check	Ripped	Paraplowed	Ripped	Paraplowed
Boxall	Wheat	3168	4502	4084	42	29
McEwen (1)	Flax	2853	3420		20	
McEwen (2)	Flax	3307		3261		-1
Morgan	Flax	3495	4115		18	
Rice	Canola*	?	?		10	
Chabot	Peas	5338	6229		17	
Cragg	Wheat	5579	5329		-4	
Foisy	Lentils	6846	6559	6541	-4	-4
Harrington	Wheat	2564		2536		-1
Millar	Flax	5717		5599		-2
Jessiman	Wheat	5735	5881	6286	3	10
Ackerman	Wheat	2565	3465		35	
Swenson	Wheat	4456	5138		15	

*Yield increase was estimated by the farmer.

sites show a different pattern. At Chabot's there is a yield increase of 17%, while at Cragg's the yield decrease is only 4%. This would therefore indicate that the crop was "greener" and thus "late" in the ripped strips at these sites.

Water use efficiency is a measure of the amount of grain produced per cm of water available. The water use efficiencies for all 12 locations is listed in Table 3. Water use efficiency was greater in the ripped fields, but not in the paraplowed fields. The biggest differences were in wheat production where deep ripping resulted in substantially greater W.U.E. Improved crop water uptake would be a direct result from improved soil structure due to deep ripping.

Table 3. Water use efficiency for all 12 field experiments.

Location	Crop	Ripped	Control	Paraplow
		----------	kg/ha/cm	----------
Chamberlain	Wheat	43.5	39.5	
Moose Jaw	Wheat	112.7	94.0	
Tisdale, Boxall	Wheat	89.6	47.2	69.0
Arborfield, Cragg	Wheat	53.6	67.5	
Glenside	Wheat		49.7	48.2
Lucky Lake	Wheat	110.6	126.2	116.7
Tisdale, McEwen	Flax	49.8	45.5	
Tisdale, McEwen	Flax	81.4	68.5	
Birsay	Flax		75.8	78.1
Arborfield, Chabot	Peas	52.2	63.8	
Cut Knife	Lentils	94.5	91.0	84.9
Average values	All crops	76.4	67.3	72.5
Average values	Wheat	74.9	59.6	58.6
Average values	Flax	65.6	57.1	57.9

Solonetzic soils generally are found with extreme field variability in crop yields. The average variability in crop yields was reduced from 25.7% to 20.3% in the ripped areas and to 17.1% in the paraplowed areas.

Soil strength was evaluated by measuring the resistance required to push a narrow rod into the soil at 5 cm depth. This measurement was carried out at harvest time. The average soil strength was reduced by 23% due to deep ripping and by 10% due to paraplowing.

Deep ripping results in 1987 were affected by the weather, in particular the rainfall pattern. At Arborfield the average precipitations for the months of May and June were 71% and 65% of normal. This relatively dry period did little to offset poor seedbed conditions in the ripped strips at Chabot's and at Cragg's, resulting in poor crop stands. At 6 other sites (Glenside, Cut Knife, Birsay, Lucky Lake, Moose Jaw and Chamberlain), precipitation for the months of July and August was above normal (119% and 116%, respectively). Timely rainfall in these 6 sites was therefore able to alleviate some of the moisture stress plants were under. This phenomena would "mask" the effect of deep ripped soil structure on crop water uptake. It therefore is quite possible that in a drier year, yield differences due to deep ripping would have been more substantial.

In summary, deep ripping produced substantial yield increases in the Tisdale area. Poor seedbed conditions at Arborfield resulted in yield decreases due to deep ripping. In 6 other sites yields following deep ripping were equal to or marginally greater than the check yields. Timely rainfall conditions may have "masked" the deep ripping effect on these 6 sites. Paraplowing resulted in a substantial yield increase only at one site. Water use efficiency was greater following deep ripping, but not following paraplowing. Both deep ripping and paraplowing reduced field variability in crop yield. Soil strength was reduced by both deep ripping and paraplowing.

The 1987 results represent the second year of the study. Substantial yield increases were found in 1986, as earlier reported. Many questions still remain to be

answered. The economic feasibility of deep ripping appears to be positive for solonetzic soils in the Tisdale region. However, yield increases must persist for more than 2 years before it "pays" to deep rip under these circumstances. No significant yield increases were found in 6 other sites. A "dryer" year may tell a different "story" with respect to deep ripping. It is therefore essential that these sites be monitored for another two year period. It is otherwise difficult to make recommendations to farmers in Saskatchewan.

Footnote: The results of the 1987 deep ripping research including statistical analysis will be presented at the 1988 Soils & Crops Workshop in Saskatoon, Saskatchewan.